frontiers | Frontiers in Earth Science

TYPE Editorial
PUBLISHED 02 December 2022
DOI 10.3389/feart.2022.1076801

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OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Geohazards and Georisks, a section of the journal Frontiers in Earth Science

RECEIVED 22 October 2022
ACCEPTED 23 November 2022
PUBLISHED 02 December 2022

CITATION
Jiang H, Xu C, Adhikari BR, Liu X, Tan X and Yuan R (2022), Editorial: Environmental change driven by climatic change, tectonism and landslide.
Front. Earth Sci. 10:1076801.
doi: 10.3389/feart.2022.1076801

Editorial: Environmental change driven by climatic change, tectonism and landslide

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KEYWORDS
tectonism, sedimentation, landslide, paleoclimate, Climatic evolution, hazard assessing

Editorial on the Research Topic
Environmental change driven by climatic change, tectonism, and landslide

Introduction

Landscape evolution responds to climate change and tectonic motions, and this response is usually mediated by sediment transport and landslides (Whipple, 2004; Jerolmack and Paola, 2010). Understanding the transmission of environmental signals is crucial for predicting landscape response to climate change, and interpreting paleoclimate and tectonics from stratigraphy. Landslides and sedimentation are important surface processes, and the sediments contain important tectonic and climatic information.

Previous investigations in landslides and sediments focus mostly on climatic variations at the expense of tectonic inputs (Jiang et al., 2022). Recent investigations from tectonically active regions reveal many seismic events from modern landslides and late Pleistocene lacustrine sediments corresponding to tectonic activities (Howarth et al., 2012; Howarth et al., 2014; Jiang et al., 2014). In this context, it is of great scientific significance to consider the role and interplay of both tectonics and climate in geodynamic evolution as preserved in sedimentary records and landslide hazards.

On the other hand, for a regional scale of landslide hazard assessment, the characteristics of landslide and causative factors can be spatially different due to the sizable study area. The stability of slopes in seismically active areas has become one of the popular Research Topic in the field of geological disaster prevention (Chen et al., 2022). Searching for the environmental context of climatic evolution and tectonism crucially depends on the interpretation of paleoclimate and tectonic archives from outcrop geology, basin sediments, river sediments, soft sediment deformation, landslides, geological hazards, and so on. Linking sedimentological processes to paleo-environmental reconstructions and models becomes increasingly important.

To present the latest achievements in this direction, we organized a Research Topic entitled *Environmental change driven by climatic change, tectonism, and landslide*. This Research Topic includes seven articles covering seismic and human impacts inferred from lake sediments, tectonic activities on the millennial- and million-year scales, and landslide hazard assessment and seismic amplification of the soil-rock slope, representing the newest progress in this discipline.

Seismic and human impacts inferred from lake sediments

The instrumental and historical earthquake records of a region are generally far too short to adequately evaluate the long-term behavior of seismogenic faults. Paleoseismology helps to fill this gap through detailed analysis of the available geological record along faults. Recently, more attention has been paid to paleoseismic records from lacustrine settings, with a greater emphasis on earthquake sedimentology (Jiang et al., 2017). Magnetic susceptibility, sedimentary structures, geochemistry, particle size, and pollen analyses are the preferred tools for identifying seismic events in lake sediment sequences (Jiang et al., 2014; Jiang et al., 2016; Jiang et al., 2017; Liang and Jiang, 2017; Wei et al., 2021). Intriguingly, different regions usually generate some new indicators for seismic activities.

Based on sedimentary characteristics (color, density, and grain size), organic matter content, and high-resolution XRF element scanning data, Liu et al. identified four seismic events from Lake Mugeco along the Xianshuihe fault zone on the southeastern margin of the Tibetan Plateau over the past 300 years, which are well correlated with four historical earthquakes. This result shows that only earthquakes with seismic intensities from VII to VIII within a 40-km radius can be recorded by lacustrine sediments in Lake Mugeco though the historical records reveal there are frequent earthquakes over Ms6. 0 along the Xianshuihe fault.

The Fuyun Fault is a typical slow-slipping fault in northwest China. Whether it left seismic imprints in nearby lake sediments remains uncertain. Fan et al. obtained two long sediment cores from Lake Yileimu and analysis of multi-proxies shows that sorting indices >3 and Si contents >700 counts per second (cps) are two effective tools to identify seismic events. Combined with analyses of sedimentary structures, magnetic susceptibility, elemental composition and carbon content, a total of 20 seismic events are identified by the Y20B core.

Besides seismic signals, lake sediments have the potential to provide excellent archives for long-term human impacts. Vegetation clearance and burning and agricultural and settlement expansion have led to increasing regional soil erosion rates (Arnaud et al., 2012). Moldovan et al. selected Lake Zaton in the Romanian Carpathians as a temporary lake for analysis of the human impact and the results show that, over the past 2,200 years, natural cycles of warm and cold periods changed the oribatid communities around the lake, with warmer cycles of rich fauna alternating with poor fauna during colder periods. However, the increased human occupation in the study area replaced the ecologically diverse fauna with eurytopic taxa in the past few centuries. This work indicates that the combined effects of climate change and long-term human impacts can have deleterious effects on invertebrate species and communities on the regional scale.

Tectonic activities on the millennial- and million-year scales

The collision of the Indian plate with the Eurasian plate led to the most complicated active structure in the southeastern margin of the Tibetan Plateau. The Gaoligong Mountain shear zone (GLGSZ) is one large-scale strike-slip fault zone with typical structural features that extend for thousands of kilometers (Allen et al., 1984; Royden et al., 2008). Wang et al. collected *in situ* samples of fresh gneiss and granite in the transects of the Gaoligong Mountain, Guyong Rock Mass, and Yinghuagu Valley for low-temperature thermochronological analysis. This work reveals that the GLGSZ experienced two rapid exhumation events at ~14.5 Ma and ~2.9 Ma. A collective comparison indicates that the deformation processes began in the northern transect and continued southwards and controlled the geomorphological features of the Gaoligong Mountains.

Relative to western China with more earthquakes, eastern China remains relatively stable with fewer earthquakes. However, in recent years, the seismic and geological survey discovered a new active fault-the Kouma Fault in the western Henan Province. Combined with trenching, drilling survey, magnetotelluric sounding and radiometric dating, He et al. conducted a detailed investigation on 12 fault outcrops on the slopes of the loess gullies and revealed two paleoseismic events of the Kouma Fault in the Middle Pleistocene and 40.9–38.8 ka B.P. This work is significant for the potential seismic source zone division, urban and rural land planning, and the assessment and prevention of earthquake disaster risk.

Landslide hazard assessment and seismic amplification of the soil-rock slope

Earthquakes have long been recognized as one of the main triggers for landslides across the Earth (Keefer, 1984; Tian et al., 2022). The earthquake-triggered landslides threaten our society through their direct and indirect, long-term effects such as damaged infrastructure, increased debris flows and floods associated with landslide dam failures and downstream river aggradations (Zhang et al., 2021; Xu et al., 2022). Zhang et al. proposed landslide hazard assessment based on zonation in an attempt to take effective measures to address this problem. The study area is the China-Pakistan Economic Corridor and the main controlling factors for landslides were related to the site's topography, land use, and distance to an earthquake epicenter. This work shows that the accuracy of hazard assessment maps by zones was higher than that of the whole study area. Wang et al. established a centrifuge shaking table model test of anchored stabilizing piles for strengthening landslides and analyzed the dynamic response characteristics of the pile-anchor-slope under earthquake action. This work shows that the seismic amplification of the complex soil-rock slope varied strongly. The amplification of the pile-anchor cable connection is the largest, and the high-angle soil-rock interface is the smallest. Based on the obtained results, relevant suggestions for engineering design were put forward.

Concluding remarks and prospects

Landscape evolution deals with climate change, tectonism, and even human impacts, representing a complicated process. In this Research Topic, the seven articles involve multiple studying directions and accumulated much new knowledge for the development of this discipline.

The lacustrine deposition has two advantages, i.e., the innate continuity and reliability of systematic dating. Conventional paleo-seismic studies can reveal tectonic activity in localized locations or short segments, while earthquake limnology can effectively scale into basins and reconstruct seismic sequences through the recovery of sedimentary process over a large area (Jiang et al., 2014; Jiang et al., 2017). These studies make a common sense that the lacustrine deposits are the best archives of a long-term paleoseismic reconstruction and of a great importance for assessing the improvement of seismic hazards and risks in tectonically active regions.

Temporary lakes, such as Lake Zaton, can be used for paleoenvironmental studies, where natural and anthropic processes can significantly affect sediment deposition. Thus, multiple indicators of past environments can be used to assess human presence by decoupling from the rhythmic climate changes. Landslide hazard assessment based on zonation has higher accuracy than that of the whole study area, pointing to a new direction of landslide study in the future.

At the same time, these studies provide some good suggestions, for example, shallow and deep seismic explorations should be conducted in eastern China in the future to understand the tectonic activity of faults like the Kouma Fault. To study slope amplification and the seismic behavior of the pile, more available engineering cases and model test data should be obtained in the future to improve the numerical simulation.

Author contributions

All authors contributed to the critical review of the articles published in this Research Topic. HJ has provided an initial draft of this Editorial which was revised and approved by all the authors.

Funding

This study was supported by the special project of the fundamental scientific research of the Institute of Geology, China Earthquake Administration (IGCEA 1906).

Acknowledgments

We deeply thank all the authors for their submissions to this Research Topic and all the reviewers for their valuable comments and suggestions, and the Frontiers Editorial Office for their strong support in all phases of the realization of this Research Topic.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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